Amendments to the Specification:

Please replace the paragraph on page 1 that immediately follows the heading "REFERENCE TO RELATED APPLICATIONS", with the following amended paragraph:

This application is related to a companion application, Serial No. 09/574,841 [[_________,]] (IOS-118A), filed on even date herewith and assigned to the assignee of the present application.

Please replace the paragraph beginning on page 2, line 7, which starts with "The present invention", with the following amended paragraph:

The present invention is directed at extensions of the bulk techniques described in the above-noted [[theses]] thesis to sol-gel thin films. Specifically, a technique for the photolithographic fabrication of integrated optic structures in thin films of photosensitive sol-gel glasses is described here. This technique involves the formation of a photosensitive sol-gel, including an organometallic photosensitizer, on a suitable substrate (glass, silicon, or any other support material). Next, the photosensitive film is exposed to white or ultraviolet light inducing a photochemical reaction in the photosensitive sol-gel glass network with the end photo-product being a metal oxide. The photodeposited metal oxide is permanently bound to the sol-gel film glass network as a glass modifier during a heat treatment process, which in turn induces a permanent refractive index increase in the glass. The refractive index increase is dependent on the concentration of the photosensitizer and on the light energy used in the exposure process. Therefore, a spatially varying light intensity during exposure results in a spatially varying refractive index profile. This refractive index profile induced in the film can be designed to guide light.

Please replace the paragraph spanning pages 2 and 3 of the specification with the following amended paragraph:

Exposure of the photosensitive sol-gel film to white or ultraviolet light induces the unbinding of the metal from the photolabile moiety component of the photosensitizer followed by the binding of the metal to the sol-gel film. The exposed regions of the sol-gel film are converted to a metal oxide silica film by first and second step heatings at a low temperature and high temperature, respectively. The low temperature drives out the unexposed (unbound) photosensitizer and the unbound photolabile moiety. The higher temperature step unbinds the organic component from the bound photosensitizer and drives it off. This step also permanently binds the metal to the silica film forming a metal oxide glass modifier. If the sol-gel film is deposited [[in]] <u>on</u> a glass or silicon substrate, a metal oxide doped silica region of Si-O-M-O-Si is formed in the exposed regions acting as a glass modifier which in turn modifies the refractive index. The unexposed photosensitizer is driven off during the heat treatment steps. Since no material is removed from the sol-gel film in this process, as in the case of prior-art-processes, the resulting top surface is planar, thus leading to a simpler process for producing devices and increase lifetime of resulting devices.

Please replace the paragraph beginning on page 4, line 5, which starts with "The invention thus", with the following amended paragraph:

The invention thus is based on the realization that the richness in the number and variety of constituents which can be included in a sol-gel film enable unique integrated optic structures to be fabricated, particularly with the use of photo masks, which are not achievable with alternative techniques. Specifically, the technique permits a high degree of control not only in defining high index of refraction channels in a sol-gel film but also in controlling the index of refraction incrementally along the length of the channel and from channel to channel in multichannel devices such as wavelength division multiplexers (WDM). Accordingly, the index can be changed to enable strongly guided waveguides to be fabricated creating low-loss, small bend radii thus permitting a large number of channels to be fabricated in a single film. A two-hundred and fifty-six channel wavelength division [[multiplexer ,]] multiplexer, for example, can be made in a very small chip because of the tailoring of the indices of refraction channel to channel and along the length of the channel. Moreover, the ends of the channels can be made with [[indicies]] indices of refraction to obtain NA matching to optical fibers.

Please replace the paragraph beginning on page 6, line 17, which starts with "The invention is based", with the following amended paragraph:

The invention is based on the recognition that a photosensitive sol-gel film including an organometallic photosensitizer can be made into a metal oxide material when exposed to ultra violet or white light in the wavelength range of from about 200 nm to 700 nm followed by a controlled heat treatment. The invention is further based on the realization that the exposure of such a film to that light through a photo mask can be made to produce a waveguide channel of relatively high

index of refraction, metal oxide material sandwiched between regions of dielectric, low refractive index material. Furthermore, based on the selection of appropriate precursors, the photodeposited metal oxide doped waveguide exhibits non-linear optic properties (semiconductive, electro-optic, magneto-optic and/or all optic) so that electrodes placed adjacent to the waveguide for creating electric [[fileds]] <u>fields</u> in response to applied voltages can induce temporary charges in the refractive index of a waveguide. [[.]]

Please replace the paragraph beginning on page 7, line 5, which starts with "In this context," with the following amended paragraph:

In this context, fig's 1 and 2 show schematic side views of a work piece 10 and 20 respectively. In fig. 1, a silicon substrate 11, 6" x 6" x 1 mm, is coated with a silicon dioxide (deposited or grown) layer 1 - 2 microns thick. The silicon dioxide layer has a photosensitive sol-gel film 13 formed on it by ~~well understood~~ <u>well-understood</u> techniques such as spinning and/or dip coating.

Please replace the paragraph beginning on page 7, line 15, which starts with "The notation - R -", with the following amended paragraph:

The notation - R - refers to anyone of a group of volatile organic materials including CH_3; CH_3 - CH_2, CH_3 - CH_2 - CH_2 [[-and]] <u>- and</u> the like. The notation - M - refers to any one of the metals of group [[IVA]] <u>IVB</u> of the periodic table including Ge, Sn and Pb; group [[VI]] <u>VIB</u>

including Se and Te; group [[VIII]] VIIIA including Fe, Co, Ni; and group [[IVB]] IVA including Ti and [[Zn]] Zr and rare earth metals such as [[En]] Er, Eu, Pr and [[Tu]] Tm. The concentration of the metal determines the index of refraction of the sol-gel film in conjunction with the [[engery]] energy of the light used in the subsequent exposure steps.

Please replace the paragraph beginning on page 8, line 1, which starts with "The photosensitive sol-gel film," with the following amended paragraph:

The photosensitive sol-gel film, in accordance with the principles of this invention initially includes R - M - X as indicated in ~~each of~~ fig. 1.

Please replace the paragraph beginning on page 9, line 13, which starts with "The inclusion of materials", with the following amended paragraph:

The inclusion of materials such as tin oxide, lead oxide, titanium oxide, and ~~Zirconium~~ zirconium oxide, thulium oxide allows for the fabrication of electro-optic switches. The inclusion of materials such as iron, iron oxide, nickel and nickel oxide allows the fabrication of magneto-optic switches. The inclusion of rare earth materials such as erbium oxide, neodymium oxide, ytterbium oxide and ~~praesodymium~~ praseodymium oxide allows the fabrication of all optical switches.

Please replace the paragraph beginning on page 10, line 5, which starts with "Similar effect occurs", with the following amended paragraph:

A ~~Similar~~ similar effect occurs in the case of the magneto-optic switch. In this case a waveguide with magneto-optic properties is used, such that the variation of a magnetic field in the vicinity of the magnetic waveguide leads directly to a variation in the real and imaginary components of the refractive index. Hence, by applying a magnetic field to the structure, the light output in fig. 4 can be switched between the two waveguide arms (Pol and Po2) of the structure.

Please replace the paragraph spanning pages 10 and 11 of the specification with the following amended paragraph:

Fig. 6 illustrates a tunable Bragg grating filter operable to reflect a selected wavelength. The figure shows a channel 70 fabricated as discussed in connection with fig's 1 and 2. The Bragg grating is indicated at 71 and electrodes 72 and 73 are located to produce an electric field to change the index of refraction of the channel at the grating. In the presence of the field, an input signal with wavelengths $\lambda 1$, $\lambda 2$ --- λx --- λn ~~exits~~ enters the channel with wavelengths $\lambda 1$, $\lambda 2$ --- λn exiting the channel and wavelength λx reflected as indicated.

Please replace the paragraph beginning on page 11, line 3, which starts with "Fig. 7 illustrates", with the following amended paragraph:

Fig. 7 illustrates a tunable add/drop filter fabricated as described in connection with fig's 1 and 2. The filter includes channels 80 and 81 with a common section 82 which includes a Bragg grating 83. Electrodes 84 and 85 are positioned to generate an electric field which changes the index of refraction in section 82. An electrical field applied to the electrodes tunes the Bragg wavelength to the value [[λy]] λx depending on the magnitude of the electrical field [[to]] so that wavelength λx exits channel 81 at 87 and may be added at 88.

Please replace the paragraph beginning on page 11, line 10, which starts with "The devices of fig's", with the following amended paragraph:

The devices of fig's 3 through 7 are produced by exposing a photosensitive sol-gel film to visible or ultra violet light. The light is operative to unbind the ~~photosensitizer~~ photolabile (X) component from the photosensitizer and to bind the metal (M) permanently in the exposed region. The light, illustratively, is ultra violet in a wavelength range of about 200 nm - 400 nm and visible in the wavelength range of 400 nm to 700 nm and exposure is for 5 minutes to 48 hours duration depending on light intensity.

Please replace the paragraph beginning on page 11, line 16, which starts with "The light exposure", with the following amended paragraph:

The light exposure is followed by a sequence of first and second heating steps. The first heating step is at a temperature of about ~~300° C~~ 300°C for a period of 1 hour and results in the

driving off of the unexposed sensitizer from the entire sol-gel layer and the unbound photolabile moiety (X) from the exposed regions of the sol-gel layer. The second heating step is at about 900°C for about 1 hour duration and results in the unbinding of the R component and the driving off of that component from the entire sol-gel film. A subsequent heating step at about ~~1050° C~~ 1050°C can consolidate the pores in the sol-gel film yielding a solid, non-porous glass. The resulting structure, as shown for example in fig. 3, includes channels 41 and 42 comprising Si - O - M - O - Si materials and regions outside the channels comprising SiO_2. The channels are a metal oxide doped silica region in the embodiment of fig. 4; the regions outside the channels are electrically insulating.

Please replace the paragraph beginning on page 12, line 4, which starts with "The metal oxide", with the following amended paragraph:

The metal oxide induced by the binding of the component (M) in region 31 (of fig. 1) defines the index of refraction in the channels. Accordingly, the concentration of metal oxide can be selected so that the index of refraction in the channels relates to the ~~indicies~~ indices of refraction in regions outside the channels to define a waveguide for light. A voltage signal impressed between electrodes as indicated in fig. 3, permits further control of the index of refraction in the channels and thus to the deflection of the signals passed through the waveguide.

Please replace the paragraph beginning on page 12, line 11, which starts with "Fig. 8 is a flow", with the following amended paragraph:

Fig. 8 is a flow diagram of the method for fabricating the device of [[fig. 3]] <u>fig's 1 and 2</u>. Specifically, block 91 indicates the formation of a photosensitive sol-gel film on a suitable substrate such as silica glass or silicon containing a thermally grown silica layer. Block 92 indicates the exposure of at least one channel of the sol-gel layer to (visible or) ultra violet light. Block 93 represents the first heating step of about 300°C to evaporate the unexposed photosensitizer [[(X)]] <u>(R-M-X) and the unbound photolabile moiety (X)</u>. Block 94 represents a second heating step at about 900°C to <u>unbind and</u> evaporate the organic material (R) from the layer.

Please replace the paragraph spanning pages 12 and 13 of the specification with the following amended paragraph:

The photosensitive sol-gel process permits the precise control of refractive index to produce a variable refractive index distribution along the horizontal plane of the film. To obtain variable refractive index gradient waveguide channels, the photosensitive sol-gel film (13 of fig. 1) is exposed using a photo mask. Exposure to UV- <u>or</u> visible light through the mask induces a photochemical reaction of the photosensitizer immobilized in the sol-gel matrix. A percentage of photosensitizer transforms to a metal oxide depending on the degree of light exposure (controlled by the photo mask). The metal oxide acts as a refractive index modifier of the silica film. Thus, the use of a [[gray-scale]] <u>gray scale</u> photo mask allows the concentration of metal oxide, or refractive index profile, along the light propagation path of the waveguide (channel) to be controlled.

Please replace the paragraph spanning pages 13 and 14 of the specification with the following amended paragraph:

Fig. 13 is a schematic representation of an integrated optic chip waveguide array illustratively including four channels 120, 121, 122, and 123. The difference between the refractive index of the core (n_z) and the refractive index of the cladding (n_1) is expressed as Δn. Thus, the Δn for channel 120 is [[n_n- n_l]] <u>n_n- n_1,</u> the Δn for channel 121 is $n_4 - n_1$, the Δn for channel 122 is $n_3 - n_1$, and the Δn for channel 123 is $n_2 - n_1$.

Please replace the paragraph beginning on page 14, line 3, which starts with "The fabrication the structure", with the following amended paragraph:

The fabrication of the structure of fig. 13 is as described hereinbefore except that a photo mask is used as shown in fig. 14. As can be seen in the figure, the mask for channel 123 is almost black; the mask for channel 122 is dark gray, the mask for channel 121 is a lighter gray and even lighter for channel 120. Additional channels would require lighter and lighter masks as indicated in the figure, the range going from <u>almost</u> totally black to clear. The regions between the channels (the cladding) require a ~~clear~~ <u>black</u> portion of the mask. The use of the photo mask allows all the channels to be defined simultaneously.

Please replace the paragraph beginning on page 15, line 8, which starts with "The simultaneous", with the following amended paragraph:

The simultaneous control of refractive index differential is particularly useful in the fabrication of dense and ultra-dense, variable-index, phase-array-waveguide gratings commonly used for fabricating integrated optic WDMs; the WDM structure typically requires curved waveguides in the array. Thus, the use of a [[gray-scale]] gray scale mask and the resulting ability to achieve a variable and/or controlled refractive index in such an array allows the fabrication of [[highly - packed]] highly packed chips in a relatively small package.

Please replace the paragraph beginning on page 15, line 14, which starts with "This property also", with the following amended paragraph:

This property also is useful for producing chirped Bragg gratings useful for dispersion compensation in telecommunication systems. Fig. 17 illustrates such a prior art device. Fig. 17 shows a channel [[160]] 169 with stripes ~~161, 162, 163~~ 170, 171, 172 - - - [[n]] N where the refractive index difference Δn is constant and the spacing (e.g. 174, 175) between stripes is different.

Please replace the paragraph spanning pages 15 and 16 of the specification with the following amended paragraph:

In accordance with the principles of this invention, a chirped Bragg grating [[structure,]] structure is characterized by a refractive index change and the spacing between stripes is constant. Fig. 18 shows a chirped Bragg grating structure formed in a photosensitive sol-gel film with stripes ~~170, 171, 172~~ 161, 162, 163 - - - N where the spacings [[174, 175,]] 164, 165, - - - are constant but

the change in index of refraction [[$\Delta\eta$]] $\underline{\Delta n}$ varies from [[$\Delta\eta_1$]] $\underline{\Delta n_1}$ to [[$\Delta\eta_2$]] $\underline{\Delta n_2}$ and . . . [[$\Delta\eta_n$]] $\underline{\Delta n_n}$ along the length of the grating. The use of a photo mask permits easy control over the index of refraction difference particularly in grating structures where the periodicity is typically sub-micron.

Please replace the paragraph beginning on page 16, line 9, which starts with "Fig. 19 shows one", with the following amended paragraph:

Fig. 19 shows one such additional film 182 extending between an input 183 of ~~multimode~~ multichannel light (typically via an optical fiber not shown) and an output indicated by arrows 184.

Please replace the paragraph beginning on page 16, line 12, which starts with "A multilayered device", with the following amended paragraph:

A multilayered device of the type shown in fig. 19 is fabricated by the method described in connection with the flow diagram of fig. 20. The flow diagram indicates the steps 91 - 94 of fig. 8 are carried out to produce film 149 of fig. 19 as indicated by block 190. Thereafter, the film produced by steps 91 - 94 is used as a substrate for a second film ~~(181)~~ (182) as indicated by block 195 of fig. 20. The sequence of steps is repeated for each film required as indicated by block 196.